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(30) Priority: **01.04.1999 IT TO990256**

(71) Applicant: **Negesat Di Boer Fabrizio & C. SNC**
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(54) **Protective casing with cooling for equipment in air, space or land vehicles**

(57) A system of mechanical restraint and heat dissipation for equipment of space, air or land vehicles including at least one structure housing electronic components and/or apparatuses, said system comprising el-

ements (8) of elastic-damping material (10), coated with at least one layer (11) of a thermally conductive material, said elements being located inside said apparatuses and/or between the apparatuses, inside said structure.

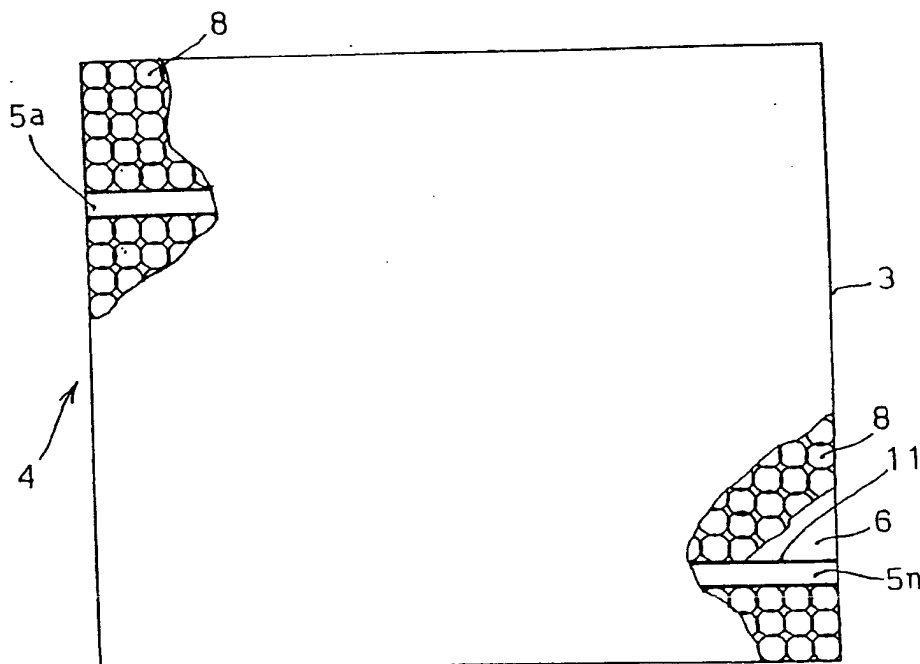


FIG. 2

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chanical vibrations, thereby resulting in a practically negligible dynamic amplification.

[0026] A second object of the present invention is to provide a system of mechanical restraint and heat dissipation which is cheap and easy to manufacture, and which moreover can be implemented both within the equipment racks and between the equipment and the structure housing it.

[0027] The above and other objects are achieved by the system of mechanical restraint and heat dissipation for space vehicles, as claimed in the appended claims.

[0028] The above and other objects of the invention will become more apparent from the description of a preferred embodiment, with reference to the accompanying drawings in which:

- Fig. 1 shows the system of the invention in a structure including a plurality of electronic apparatuses;
- Fig. 2 shows the system of the invention in a structure including a plurality of boards;
- Fig. 3 is a cross-sectional view of an element of mechanical restraint and heat dissipation according to a first embodiment of the invention;
- Fig. 4 is a schematic view of a portion of the material for mechanical restraint and heat dissipation according to a second embodiment of the invention.

[0029] With reference to Fig. 1, a parallelepiped-shaped mechanical restraint structure 2, suitable for fitting into a satellite or space vehicle, houses a plurality of apparatuses 4 connected with one another and/or with apparatuses located outside casing 7 of structure 2 through electrical connectors, not shown in the drawing.

[0030] As better shown in Fig. 2, in the example depicted, apparatuses 4 house a plurality of boards 5a... 5n mounted on a motherboard 6 and secured to the internal walls of rack 3 of apparatus 4 by means of well known securing means.

[0031] According to the invention, a plurality of elements 8 of elastic-damping material coated with a thermally conductive layer are arranged between boards 5a - 5n.

[0032] As shown in Fig. 3, elements 8 comprise a body 9, of a light elastic-damping material, coated with at least one layer 10 of a material having high thermal conductivity.

[0033] Preferably, according to the invention, elements 8 are made as cuboids 9 with sides of about 10 mm, of a low-density (5 to 30 Kg/m³) polymeric material, for instance polystyrene, polyurethane, polypropylene, polyethylene etc. Cubes 9 are moreover coated with one or more layers 10 of a material having high thermal conductivity, such as aluminium, copper, silver, gold etc., each layer being about 15 µm thick.

[0034] In this way, elements 8 will have on the one side high damping properties and on the other side a good capability of heat transmission by conduction.

[0035] Coating of cubes 9 can be effected, according to known techniques, both manually and automatically, by wrapping cubes 9 into a copper, aluminium or silver foil so as to form successive wrapping layers, in such a manner that the elastic-damping properties of the material of cubes 9 are not inhibited. It is also possible to provide a plurality of layers of thermally conductive material with different thicknesses, the limit being determined by the total inhibition of the elastic-damping properties of cubes 9.

[0036] In the alternative, bodies 9 of elements 8 may have any shape, e. g. spherical, parallelepiped, cylindrical or prismatic, and be similarly coated with any film or paint with thermally conductive properties.

[0037] The size of individual elements 8 can be chosen at will, depending on the overall size requirements.

[0038] Of course, in case of non-pressurised racks, use of open-cell polymers will be preferable for bodies 9.

[0039] Since the material of coating 10 is also electrically conductive, the surfaces of boards 5a - 5n and motherboard 6 will have to be electrically insulated, yet in such a manner that thermal conductivity is not impaired.

[0040] Electrical insulation is obtained thanks to a mixture of a urethane resin in paste form, such as for instance the product available under the name Solithane 113 from Uniroyal Chemical, to which a thermally conductive and electrically insulating powder, such as aluminium oxide, is added.

[0041] Said mixture can moreover be supplemented with additives capable of conferring the proper hardness to thin film 11 obtained by spraying the mixture onto boards 5a - 5n.

[0042] In an exemplary embodiment of the invention the mixture will contain 50% aluminium oxide powder.

[0043] Advantageously, electronic boards 5a - 5n can be electrically insulated at the manufacturing plant, before being assembled into the apparatus, or later, by spraying the aforementioned insulating mixture.

[0044] Reverting to Fig. 1, some elastic-damping spacers 20, 22 assist, within casing 7 of structure 2, in maintaining apparatuses 4 in the proper position and in ensuring sufficient room for the electric cables.

[0045] According to the invention, a plurality of elements 8 of light elastic-damping material are arranged between the internal walls of casing 7 of structure 2 and apparatuses 4, said elements being coated with a thin layer (some micron thick) with high thermal conductivity (aluminium, copper, silver, gold).

[0046] Fig. 1 refers to the case where thermal dissipation is to take place through the walls of casing 7 of structure 2 which are not exposed to solar radiation, i. e. the side, rear, top and bottom walls.

[0047] Yet, retaining and dissipating elements 8 could also be arranged between apparatuses 4, if this is advantageous.

[0048] Considering the arrangement shown in Fig. 1, it is understood that, in case the walls of casing 7 of

5. A system according to claim 2 or 3 or 4, wherein the size or the number of said elements (8) are such that they become partially crushed when they are located inside said equipment (4) and/or between apparatuses in said equipment (4), inside said structure (2). 5
6. A system according to any preceding claim, wherein said bodies (9) are made of a polymeric material. 10
7. A system according to claim 6, wherein said polymeric material is polystyrene, polypropylene, polyurethane, polyethylene.
8. A system according to claim 6, wherein said casing (7) is hermetically sealed and contains air. 15
9. A system according to claim 6, wherein said casing (7) is hermetically sealed and contains a cooling fluid. 20
10. A system according to any of claims 2 to 5, wherein the casing (7) of the structure (2) is not pressurised and said bodies (9) are made of a polymeric material coated with or compressed by a material preventing its expansion and the consequent explosion. 25
11. A system of mechanical restraint and heat dissipation for electronic components and/or equipment carried on board of space or air or land vehicles, characterised in that it comprises a compacted wool of fibres (8') of thermally conductive material. 30
12. A system according to claim 11, wherein said vehicle includes at least one structure (2) for housing electronic equipment (4) and wherein said wool is located inside said equipment (4) and/or outside said equipment (4), inside said structure (2). 35 40
13. A system according to claim 12, wherein said wool is an iron, steel, aluminium, copper, silver or gold wool.
14. A space, air or land vehicle carrying electronic components and/or equipment, characterised in that it comprises a system of mechanical restraint and heat dissipation as claimed in any of claims 1 to 13. 45 50

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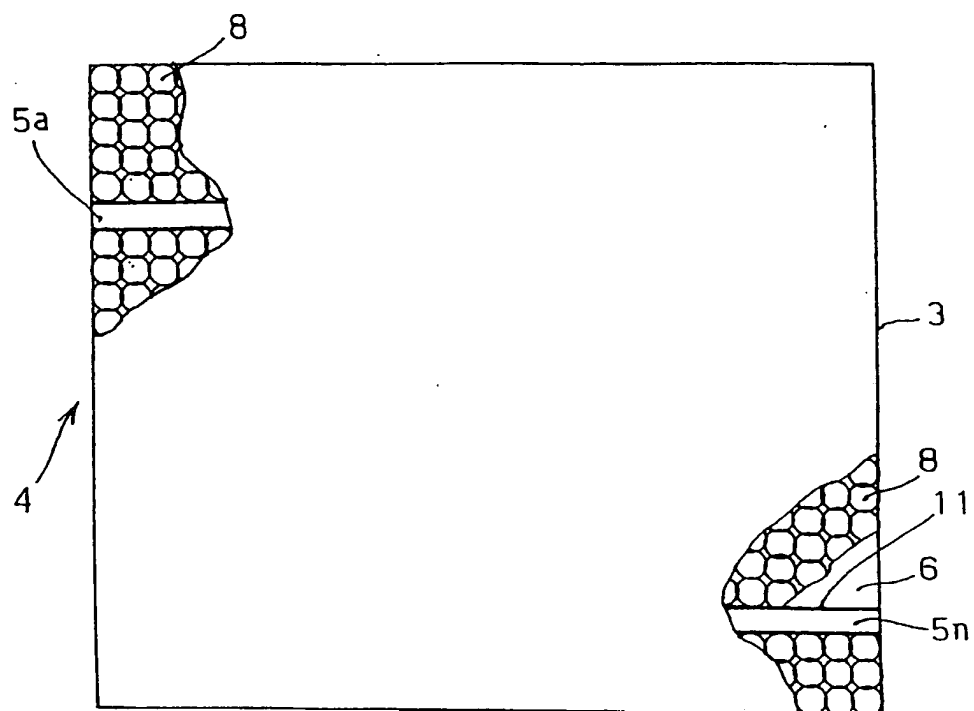


FIG. 2

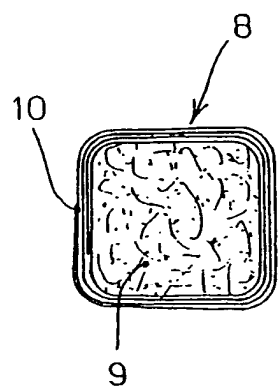


FIG. 3

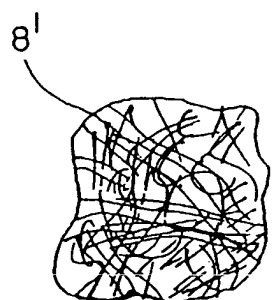


FIG. 4

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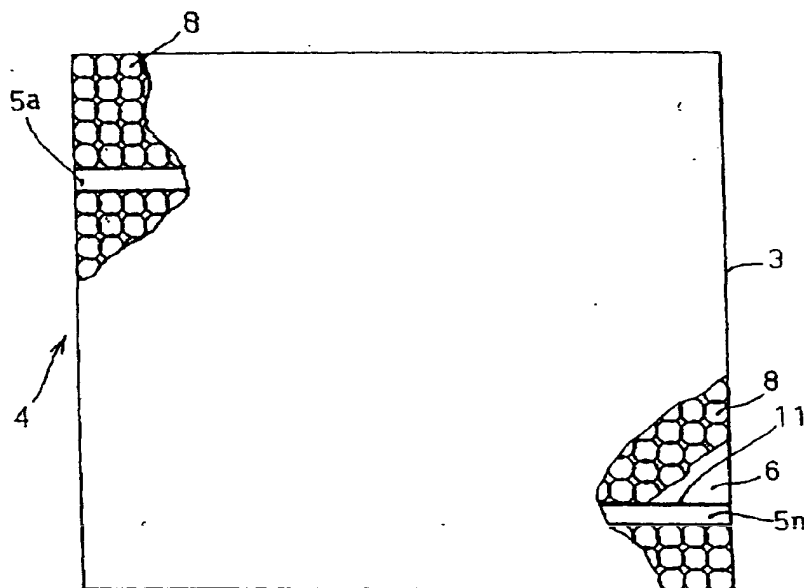


FIG. 2

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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-10, 14 when dependent of any of claims 1-10

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 10 6877

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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07-05-2001

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